A Systematic Review of Functional Outcomes of Autologous Chondrocyte Implantation and Mosaicplasty in Treatment of Articular Knee Cartilage Defects

Essay

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Abstract

Background

Chondral and osteochondral defects constitute a major problem for young patients especially athletes, they result in pain, swelling and sometimes locking. Autologous chondrocyte implantation (ACI) and mosaicplasty have been used for treatment along the past 20 years especially for large lesions, we conduct this systematic review to compare the functional outcome of each intervention and determine which technique is superior in treatment.

Methods

The search of literature was conducted using electronic databases of The Cochrane library, MEDLINE, Journal of bone and joint surgery (JBJS), Google scholarly articles and Sciencedirect and after assessment 11 studies were obtained according to inclusion and exclusion criteria; 6 randomized control trials (level II of evidence), and 5 case series studies (level IV of evidence)

Results

After evaluation of all studies included; autologous chondrocyte implantation and mosaicplasty are nearly similar as regard functional outcome. however, mosaicplasty results decline in long term follow up .

So mosaicplasty could be recommended according to the short term results as it is single stage operation and of a lower cost.

Conclusion

No difference between ACI and mosaicplasty as regards functional outcome.

Keywords:

"Mosaicplasty", "OATs", "autologous cartilage transplantation", "osteochondral cylinder transplantation", "autologous chondrocyte implantation", "matrix autologous chondrocyte transplantion", "osteochondral", "knee", "cartilage".

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LIST OF ABBREVIATION

ACI	:	*Autologous Chondrocyte Implantation*
ICRS	:	*International Cartilage Repair Society*
IKDC	:	*International Knee Documentation Committee*
JBJS	:	*Journal Of Bone And Joint Surgery*
MACI	:	*Matrix Autologous Chondrocyte Implantation*
OAT	:	*Osteochondral Autologous Transplantation*
PRISMA	:	*Preferred Reporting Items For Systematic Reviews And Meta-Analyses*
RCT	:	*Randomized Control Trials*
UK	:	*United Kingdom*

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INTRODUCTION

One of the biggest problems that still faces knee surgeons are chondral and osteochondral lesions, especially when they occur in young individuals and athletes. It is a basic requisite to preserve the anatomical structure and physiological properties of the articular cartilage for sound functioning of the knee joint.

Chondral lesions are not uncommon. Their incidence has been estimated to be around 60% in those undergoing arthroscopy[(1)]. Chondrocytes in mature articular cartilage lose their capacity to divide, receiving their nutrition and maintaining their existence mainly through synovial fluid so their intrinsic capacity to repair is very limited which in turn leaves chondral lesions resistant to healing. These lesions can cause pain, edema and joint locking. If they are not properly treated, they can cause osteoarthrosis, particularly if they are located in load-bearing areas [(15)].

Surgical interventions that are currently used for treatment of cartilage lesions includes marrow-stimulating techniques (reparative) and reconstructive techniques [(2)].

The marrow-stimulating techniques (e.g. microfracture, surgical drilling) allow migration of bone marrow cells derived from subchondral bone to cartilage defect area[(3)]. These

techniques aim at recruiting mother progenitor cells as potential cartilage precursors, which form into chondrogenic cells producing fibrocartilage[4]. However, over the time, these techniques do not stop the progression of the degeneration. The lesions already show new fiber degeneration and cell death in after one year follow up[5]. Reconstructive techniques (e.g. mosaicplasty) use autografts, allografts or synthetic material, usually in the form of osteochondral cylindrical plugs to reconstruct or replace the lesion[6]. The technique consists of removing small bone cylinders from the periphery of the femoral condyle and inter-condylar region and transplanting them to areas where there are chondral and osteochondral lesions, to maintain the quality and structure of the articular cartilage[7].

The first known biological approach aiming at restoring the normal histology and physiology of articular cartilginous lesions is autologous chondrocyte implantation (ACI)[8]. ACI is a two-stage intervention. In the first surgery, pieces of healthy cartilage are harvested from a less-weight-bearing area of the articular surface. Individual chondrocytes are isolated and cultured in vitro. During the second surgery, the cultured chondrocyte cells contained in a suspension are injected in the defect area[9]. The coverage of the implanted chondrocyte is completed using autologous periosteum mainly just below and medial to tibial tuberosity thorough a separate incision; this method is being

considered the first generation ACI. Other material, such as type I/III collagen membrane, was subsequently tried and used instead of periosteum in the second generation of ACI [10]. The third generation techniques use manufactured cell carriers such as MACI, a collagen membrane cell carrier (Verigen AG, Leverkusen, Germany) aiming both to provide and stabilize the cells in the defect area[11]. In newer third generation techniques, chondrocytes are cultured in three dimensional matrices (scaffolds) before being implanted in the cartilage defect area [12]. Implantation in third generation ACI techniques can also be performed arthroscopically or with a small arthrotomy[9].

This systematic review aims to assess the effectiveness and functional outcome of ACI compared to mosaicplasty in clinically significant and symptomatic articular cartilaginous defects.

Autologous chondrocyte implantation was first described by Brittberg and Peterson in Sweden in 1994[13] while Matsasue[14] first presented mosaicplasty in 1993 and Hagnody and Kish in 1994[6]. Both techniques aimed at preserving the articular surface and the joint function and since then studies aimed at finding which is better in outcome or if there are different indications.

Surgical technique:

Injury to the cartilage of the knee alone or with its underlying bone making a chondral lesion or osteochondral lesion leads to pain and joint dysfunction especially in the young people, and repeated minor trauma may lead to osteoarthritis requiring a replacement procedure so ACI technique was designed to preserve the articular cartilage.

The patient here undergo knee arthroscopy for two reasons the first is to identify the site and the size of the lesion, to debride the lesion thoroughly to reach healthy surrounding cartilage and the second is to obtain a healthy cartilage specimen from non-articular area nearly about 500 mg(specimen weight), this cartilage specimen is preserved, minced and washed several times and undergo processing to separate chondrocytes by proteolytic proteins as colistridial collagenase and deoxy ribonuclease then it is sieved through a nylon filter several and put in a nutrient media that is changed twice weekly for chondrocyte culturing, it's kept for 14 to 21 days up to 5 weeks before implantation.

The third stage is the implantation stage, through a mini arthrotomy corresponding to the site of the lesion the lesion is identified and a periostael flap is obtained from upper medial tibia. It is sutured to the borders of the lesion by 5/0 sutures and fibrin glue except for the site where the cultured chondrocytes is injected beneath this periosteal flap[(15)].

Other material, such as type I/III collagen membrane, was subsequently tried and used instead of periosteum in the second generation of ACI.

In third generation (matrix autologous chondrocyte transplantation) a solid agarose-alginate hydrogel scaffold capable of supporting autologous chondrocytes was developed.

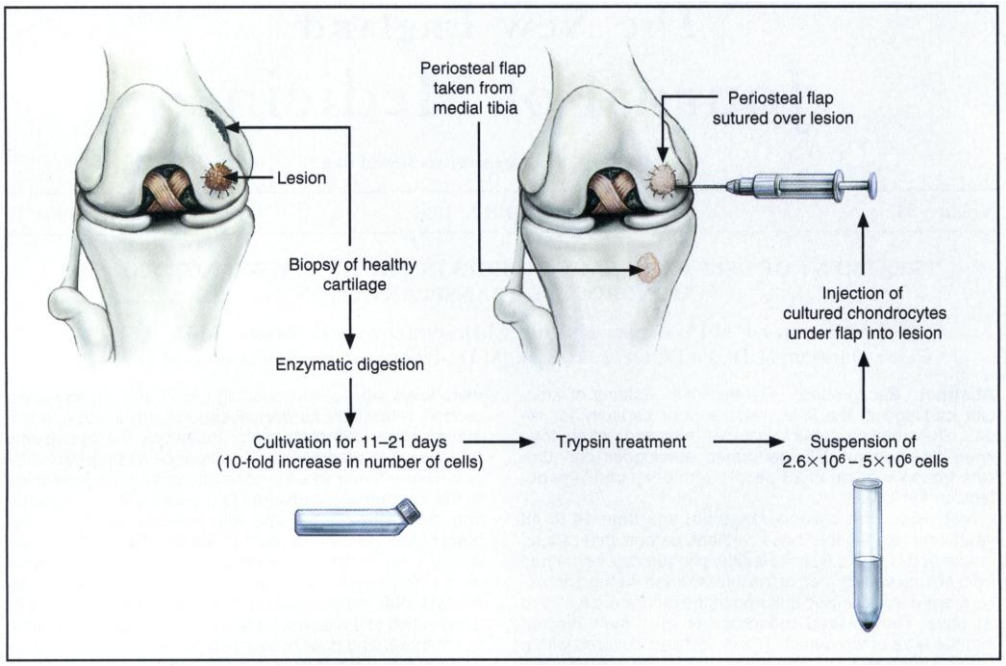

Fig. (1): Autologous chondrocyte implantation technique.[13]

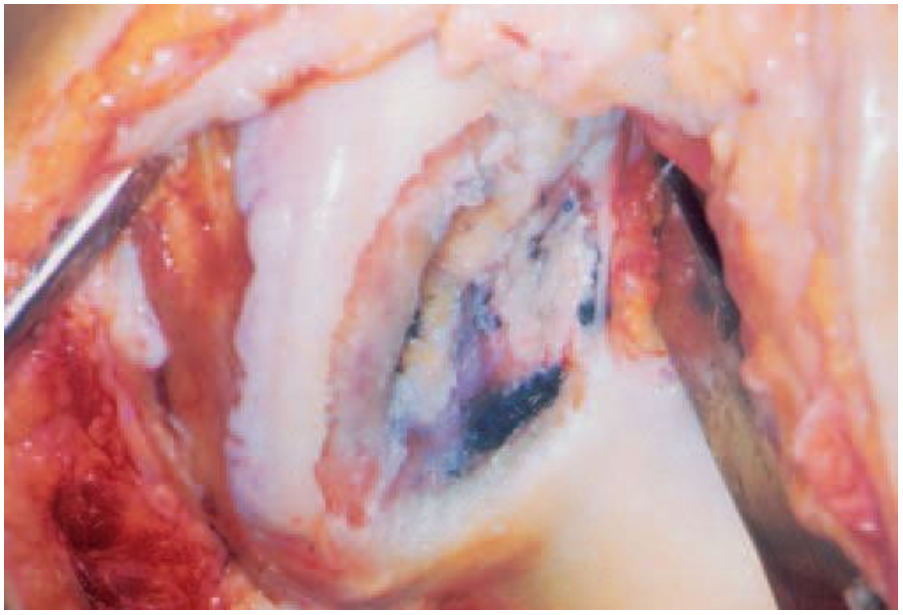

Fig. (2): Photograph showing a large (3.5 x 4 cm) defect of the medial condyle of the Femur after debridement till healthy cartilage, the black stain is from previous carbon fiber implantation.[13]

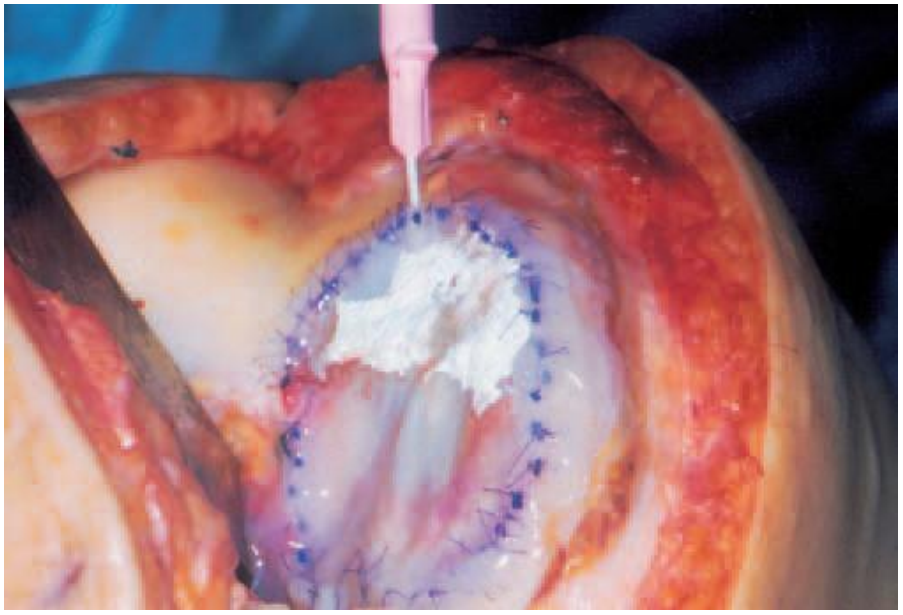

Fig. (3): Photograph showing the chondrogide membrane sutured in position with vicryl suture and chondrocytes are injected monitored by the rising mark behind the membrane.[13]

For mosaicplasty technique, large cylindrical plugs are obtained from non-weight bearing as margins of the trochlea and are arranged to fill the defect, the slope of the donor site should match the recipient site as well as the thickness of the articulating cartilage.

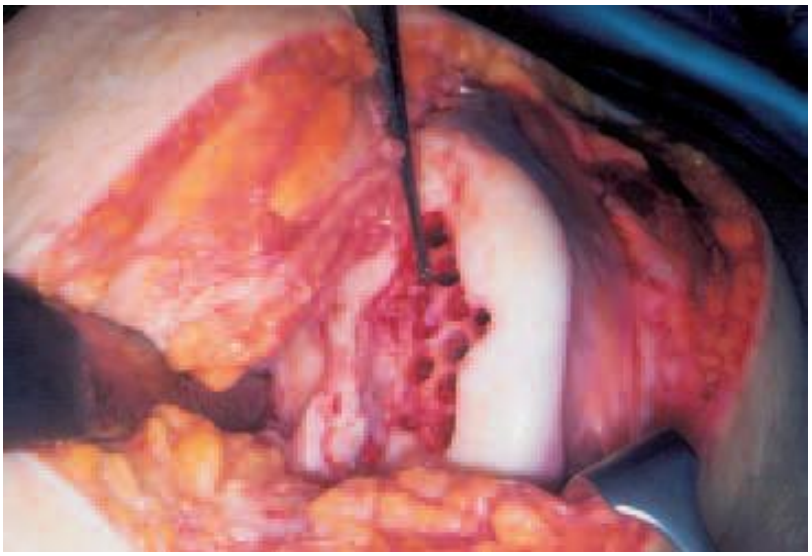

Fig. (4): This photograph demonstrates the preparation of the recipient site in mosaicplasty.[15]

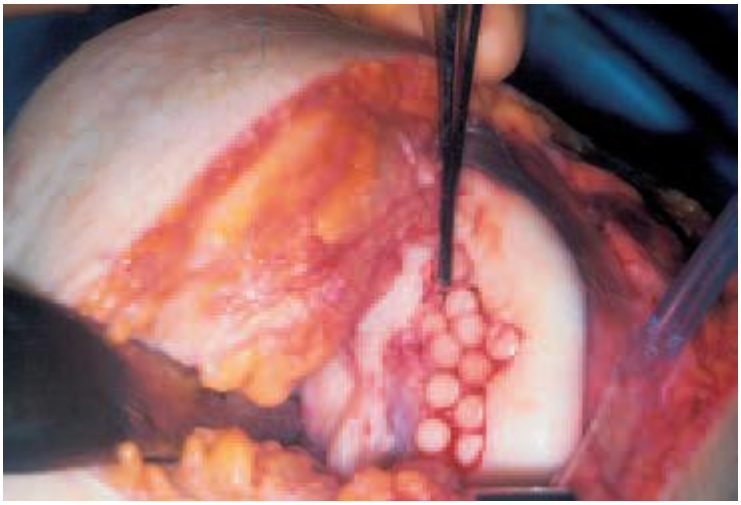

Fig. (5): The transplantation of osteochondral cylinders in mosaicplasty.[15]